*Volume 37* November, 1951 *Number 11*

# Lubrication

## A Technical Publication Devoted to the Selection and Use of Lubricants

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THIS ISSUE

THE FORD-MERCURY
AUTOMATIC
TRANSMISSION

PUBLISHED BY
THE TEXAS COMPANY
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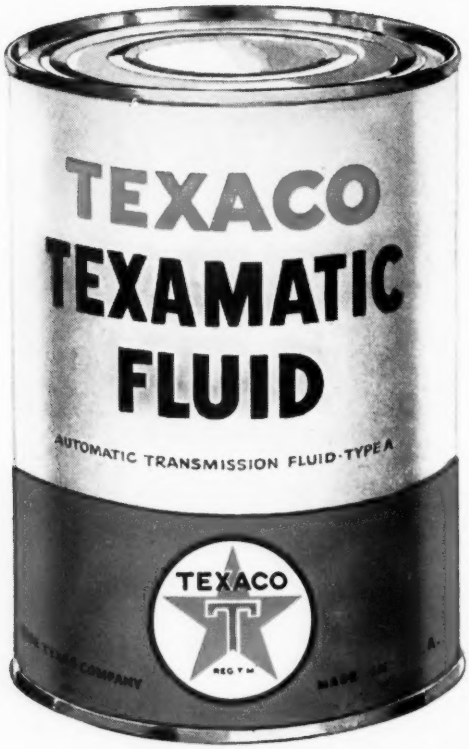


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## THE TEXAS COMPANY

# LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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# The Ford-Mercury Automatic Transmission

OUR READERS may recall that six of the eight previous issues in our series on American automatic transmissions specifically applied to *passenger car* transmissions of the following types and chronological order of appearance:

Fluid coupling and two geared speeds in driving range[1]

Fluid coupling and four geared speeds in driving range[2]

Converter-coupling with no geared speeds in driving range [5,7]

Converter-coupling with direct drive lockup and no geared speeds in driving range[6]

Converter-coupling with direct drive lockup and two geared speeds in driving range[8]

Even though some of the above were originally introduced more than ten years ago, all are still being heavily produced in essentially their original form, which in itself is a tribute to the basic soundness of their designs. While rarely indulging in direct imitation, each new member of the transmission family has at least had ample opportunity to consider the triumphs of its predecessors. Aside from complex patent considerations, the fact that only two of the six transmissions closely resemble each other illustrates that American automotive engineers rarely rest on their laurels, but are continually seeking other and perhaps better ways of accomplishing the basic purpose of an automatic transmission, viz: to increase and adjust engine torque automatically to the car's requirements and driver's demands.

During their combined analyses of existing automatic transmission preliminary to designing a new one, engineers of the Ford Motor Company and Borg Warner Corporation first selected a combination converter-coupling as one of the principal elements and further decided that the following operating characteristics would be mandatory to their prospective transmission:

"1. The transmission must go as far as necessary to provide an over-all spread of ratios sufficient to cover all conditions of maximum tractive effort when necessary and desired—to as slow an operating engine speed in top gear as can be used consistent with good performance.

2. While the torque converter combines certain

[1]Nov. 1946—"Automotive Hydraulic Transmissions"
[2]Apr. 1947—"The Hydra-Matic Transmission"
[3]Nov. 1947—"Automotive Hydraulic Transmissions, The Hydrokinetic Torque Converter"
[4]Nov. 1948—"Automotive Hydraulic Transmissions, The White Hydro-Torque Drive"
[5]Nov. 1949—"The Buick Dynaflow Transmission"
[6]Oct. 1950—"The Packard Ultramatic Drive"
[7]Nov. 1950—"Chevrolet Powerglide Transmission"
[8]June 1951—"The Studebaker Automatic Transmission". Correction Note: In the first column page 70, change word "low" in two places to "reverse".

operational advantages inherent in a fluid start, with the ability to multiply tractive effort from stall to a reasonable vehicle speed, it should also be of such a nature as to function with a minimum of slip when operating as a fluid coupling.

3. The inherent torque converter characteristic should be retained in the circuit in top gear to gain the added flexibility of performance that this device gives smoothly and automatically.

4. The automatic power circuit must be capable of giving satisfactory acceleration with the equivalent of 2nd gear start of a four-speed transmission in order to eliminate the jack-rabbit start and effect of unnecessary amount of tractive effort for all automatic starts."

As a consequence of the foregoing Bill of Requirements and several years of intensive research and development, the final or production model of the Ford-Mercury transmission contains an air-cooled single-stage three-element combination torque converter and fluid coupling assisted by a wholly-independent hydraulically-controlled compound planetary gear set, which latter provides three forward geared ratios, only two of which are used in the normal or drive range.

In simpler words, and in the normal Drive range, movement of the car is started by the combined torque multiplication effects of the converter-coupling and the intermediate gear ratio of the planetary. At some car speed above about 17 mph (the exact speed depending upon engine throttle opening), the planetary is automatically "shifted" from intermediate gear to direct or "high gear" drive, and the torque converter automatically changes to direct-drive fluid coupling operation. Since there is no mechanical lock-out device, the converter-coupling is used during all forward and reverse operation, where its hydraulic characteristics not only contribute to smoothness but are instantly and automatically available when needed for emergency torque multiplication. Due to its design and to its extensive use of aluminum-alloy components, this transmission is considerably lighter and simpler than many automatics.

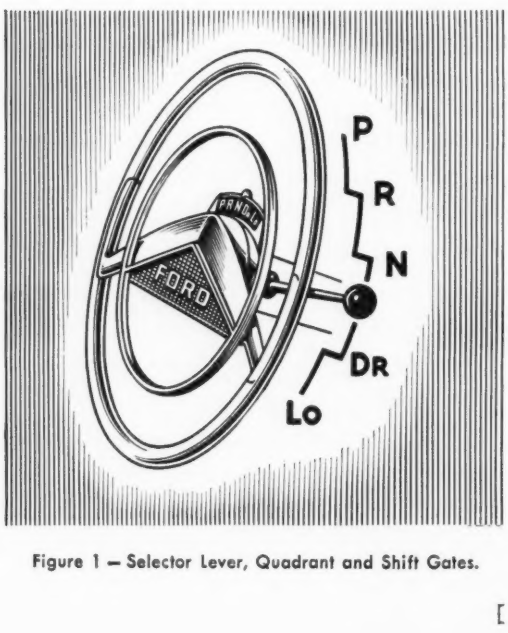



Figure 1 — Selector Lever, Quadrant and Shift Gates.

Under its trade names of "Ford-O-Matic" and "Merc-O-Matic," the Ford-Mercury Automatic Transmission is now available as optional extra-cost equipment in the 1951 Ford and Mercury Cars. It is being manufactured completely by both the Ford Motor Company and Borg Warner Corporation in their separate plants. For simplicity of reference only the name "Ford-O-Matic" will be used during the remainder of this article.

## DRIVERS CONTROLS AND GENERAL OPERATION

The only controls necessary for the Ford-O-Matic are (1) the usual foot throttle or accelerator pedal, (2) the brake pedal, and (3) the steering post selector lever. Although not apparent to the driver, the foot throttle is mechanically linked to both the carburetor throttle and to the Ford-O-Matic transmission itself. There is no conventional clutch nor obtrusive clutch pedal: hence the manufacturer took advantage of the additional floor board space thus provided to extend or elongate the brake pedal to the driver's left, thus making it easy for the driver to use either his left or his right foot (or both) on the brake pedal as convenient. Since abrupt closure of a curburetor throttle will sometimes stall an engine, the carburetor of a Ford-O-Matic equipped car is provided with a pneumatic dash pot which operates in much the same manner as the familiar door-closer.

### Selector Lever and Quadrant

As illustrated in Figure 1, the Ford-O-Matic's selector lever is located under the wheel on the right side of the steering column, is mechanically linked to the transmission, and is provided with a visual indicator dial to show the selector lever's position.

In Figure 1, the observant reader will notice that the Ford-O-Matic's normal five selector lever positions (P-R-N-Dr-Lo) are arranged quite differently from the order used in other previously-discussed transmissions (P-N-D-L-R). After considerable study the Ford-O-Matic's unique P-R-N-Dr-Lo-arrangement was chosen because (1) it provided a natural sequence of positions in the order of usual use and (2) it eliminated the need for going through a gear position that is not needed in order to reach the desired one. "Rocking" (working out of deep snow by shifting alternately and rhythmically between Lo and Reverse) as is occasionally necessary in mud or snow is completely adequate with this arrangement. Again as indicated in Figure 1, the various selector lever positions are carefully "gated" on three different levels, which not only prevents accidental movement into an unwanted position, but which, after a little experience, permits the driver to choose the desired lever position by "feel", that is, without necessarily looking at the indicator dial. For example, changes between Dr (Drive) and N (Neutral) are accomplished by a simple up or down movement of the lever, however to get into either R (Reverse) or Lo (Low) positions, the driver must pull the lever towards him while moving it. For protective reasons, to be studied later, the P (Park) position has been nicely isolated behind a double gate at the extreme uppermost position of the lever. And as a final touch, the indicator dial letters are illuminated at night when the headlights are on with the following colors: P and R—red; N—amber; Dr and Lo—green.

*P (Park)* Since movement of the selector lever into its P position operates a rigid wholly-mechanical lock which prevents any movement of the rear wheels, the shift into P position must never be made until the car has been braked to a complete stop. Unlike some other transmissions, the Ford-O-Matic's engine can *not* be started in this selector position.

*R (Reverse)* Since the torque converter with its inherent fluid-cushioning characteristics is used at all times, the car can be moving up to 5 miles per hour in forward direction when the selector lever is put into R position. However, and because of the combined powerful torque-multiplying abilities of the converter and planetary gearing, the wise driver will always depress his foot throttle moderately and cautiously when in the R position.

*N (Neutral)* Due to provision of a "neutral

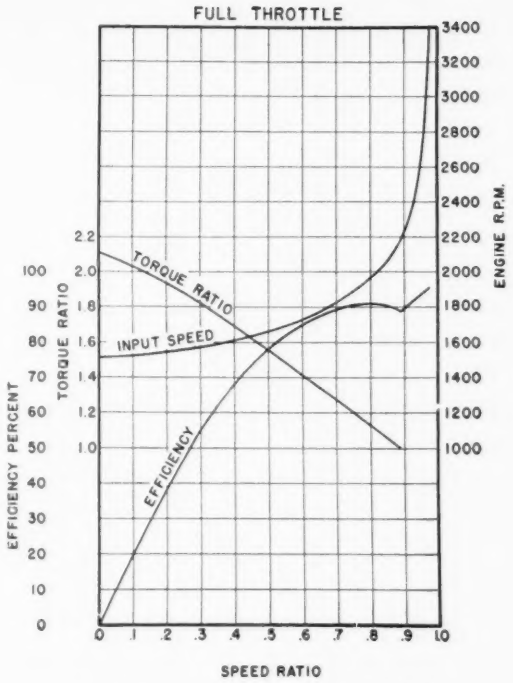


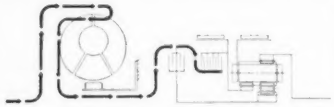
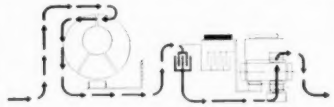
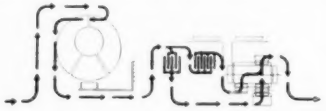
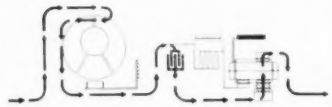

Figure 2 — Converter-Coupling characteristics.

switch" in its relay circuit, the engine's starting motor will operate only when the selector lever is in the N position. Where a "dead" battery necessitates, the engine can be started by pushing the car. For such a "Push-start" with *normal* road conditions, first move the selector lever to "N" (Neutral) position and, when the car reaches a speed of approximately 20 mph, turn on the ignition switch and move the selector lever to "Lo" position. Where road conditions do *not* provide good traction (such as on ice or snow), a satisfactory push-start may be obtained by using the "Dr" (drive) position instead of the "Lo." In all push-starts, the throttle should be held about half open until the engine is running.

*Never* tow a Ford-O-Matic or any torque-converter-equipped car to start it, since when the engine starts the torque converter may accelerate the car so rapidly that it may overtake and crash into the tow car.

*Dr (Drive)* This position is used for starting and for all normal driving in a forward direction. As previously mentioned, the Ford-O-Matic starts the car by combining the torque-multiplying abilities of both the torque converter and the intermediate or second gear of the compound planetary. Automatically, and without hesitation or interruption, the

Figure 3 From **OPERATIONS OF COMPOUND PLANETARY GEAR**

| Selector Lever Position[9] | Planetary Controls | | | | Schematic Torque Flow Diagram | Torque Multiplication Ratios | | | Overall (Transmission Converter-Coupling and 3.31 rear axle) |
|---|---|---|---|---|---|---|---|---|---|
| | Front Clutch | Front Band | Rear Clutch | Rear Band | | Converter-Coupling | Gearing | Transmission Overall | |
| P (Park, engine stopped) | Free | Free | Free | Free | | 0 | 0 | 0 | 0 |
| R (Reverse) | Free | Free | Engaged | Engaged | | 2.1 to 1.0 | 2.0 | 4.2 to 2.0 | 13.90 to 6.62 |
| N (Neutral) | Free | Free | Free | Free |  | 2.1 to 1.0 | 0 | 0 | 0 |
| Dr (Drive) Intermediate (2nd) Gear | Engaged | Engaged | Free | Free |  | 2.1 to 1.0 | 1.48 | 3.11 to 1.48 | 10.29 to 4.90 |
| Dr (Drive) High (3rd) Gear | Engaged | Free | Engaged | Free |  | 1.57[10] to 1.0 | 1.0 | 1.57[10] to 1.0 | 5.20 to 3.31 |
| Lo (Low) | Engaged | Free | Free | Engaged |  | 2.1 to 1.0 | 2.44 | 5.13 | 16.98 to 8.08 |

[9] Arranged in order from left to right on indicator or top to bottom on selector lever. See Figure 1 also.

[10] At 20 mph: transmission automatically downshifts to intermediate gear at any lower car speed

planetary is "shifted" into high or third gear when the torque producing ability of the engine and transmission (which are controlled by the driver through his foot throttle) become equal to the torque requirement of the car. In other words, under a light and conservative engine throttle, the Ford-O-Matic will shift into high or cruising range at a car speed of as low as 17 miles per hour: but when the driver indicates his desire for maximum acceleration or hill-climbing ability by applying full engine throttle, the Ford-O-Matic will remain in its powerful intermediate or second gear until a car speed of about 65 mph is attained, when a shift into high gear is obtained.

When driving at speeds under approximately 55 mph, and maximum acceleration is desired in order to pass a slow-moving vehicle or to negotiate a steep grade, the Ford-O-Matic may be downshifted from high to intermediate gear by fully depressing the accelerator pedal to the floor.

Cars equipped with the Ford-O-Matic are regularly provided with a 3.3 ratio rear axle which means in effect that cars so equipped have inherent built-in overdrive characteristics.

*Lo (Low)* The Lo range of the Ford-O-Matic is largely a rarely-used auxiliary whose single first gear easily provides the exceptionally high torque required for maximum acceleration, for extremely heavy pulling in deep snow or mud, or for ascending unusually steep back-road hills. It is also useful of course as a means of multiplying the engine's braking ability and conserving the wheel brakes during the descent of long steep grades. Once the transmission has been shifted into and attains first gear, it will remain in that gear until and unless the selector lever is moved to some other position. In other words, when in Low Range there are no "up and down" automatic shifts, which are not only disturbing, but reduce engine braking effect. The automatic control system of the Ford-O-Matic has been ingeniously modified to facilitate use of the transmission as a brake, and to safeguard both it and the engine against thoughtless or ignorant abuse. To illustrate, suppose that a Ford-O-Matic equipped car is rolling down a long steep hill in Dr range at 40 mph, is gradually gaining speed, and the driver consequently decides to utilize the Lo range as a brake. If the transmission control system permitted a direct shift from the 3rd (high) gear of Dr range to the 1st (low) gear of Lo range, the engine would have to violently and instantly accelerate from about 1700 rpm to more than 4000 rpm which, even with the cushioning effect of the converter-coupling, could be highly detrimental to the car and very dangerous to the driver. The Ford-O-Matic completely prevents this possibility by making a preparatory shift into *intermediate* gear (of the Dr range); after car speed has decreased safely and smoothly under the braking effect of this gear to about 25 mph, a second and final shift into the first (and only) gear of Lo range is automatically accomplished. In other words under this special condition an undesirable direct shift from 3rd to 1st is prevented by substituting the two more gradual 3-2 and 2-1 shifts with automatic intervening deceleration. In general, and out of respect for his engine, the driver should not go faster than about 30 mph in Lo range which requires an engine speed of about 3000 rpm.

## CONSTRUCTION AND DETAILED OPERATION

### Combination Converter Coupling

As previously mentioned, and now illustrated in Figure 4, the combination torque converter-fluid coupling used in the Ford-O-Matic is assisted in its torque-multiplication duty by planetary gearing, consequently the designers have been able to use the basic three-element single-stage type.

The converter housing is uniquely constructed from a large precision aluminum die casting into which 31 steel blades are inserted to form the converter pump. A cast iron hub embodying the front oil pump drive sleeve is bolted through the housing's central hole. The exterior of the housing is provided with integral aluminum fins which have the dual purposes of acting as fan blades by inducing cooling air and of dissipating heat to it.

The single turbine is assembled entirely of stamped or forged steel parts without any welding or brazing, each of its 33 blades being curved oppositely to those in the pump and provided with six tabs which are inserted into corresponding slots in the turbine shell and torus ring and are bent over on their inactive surfaces.

An aluminum die casting also forms the single stator or reactor wheel with its thirteen blades, the steel outer race of the sprag-type one-way clutch being keyed into the central bore. (For clarity of action only, the right hand portion of Figure 4 grossly

9 Arranged in order from left to right on indicator or top to bottom on selector lever. See Figure
10 At 20 mph: transmission automatically downshifts to intermediate gear at any lower car speed

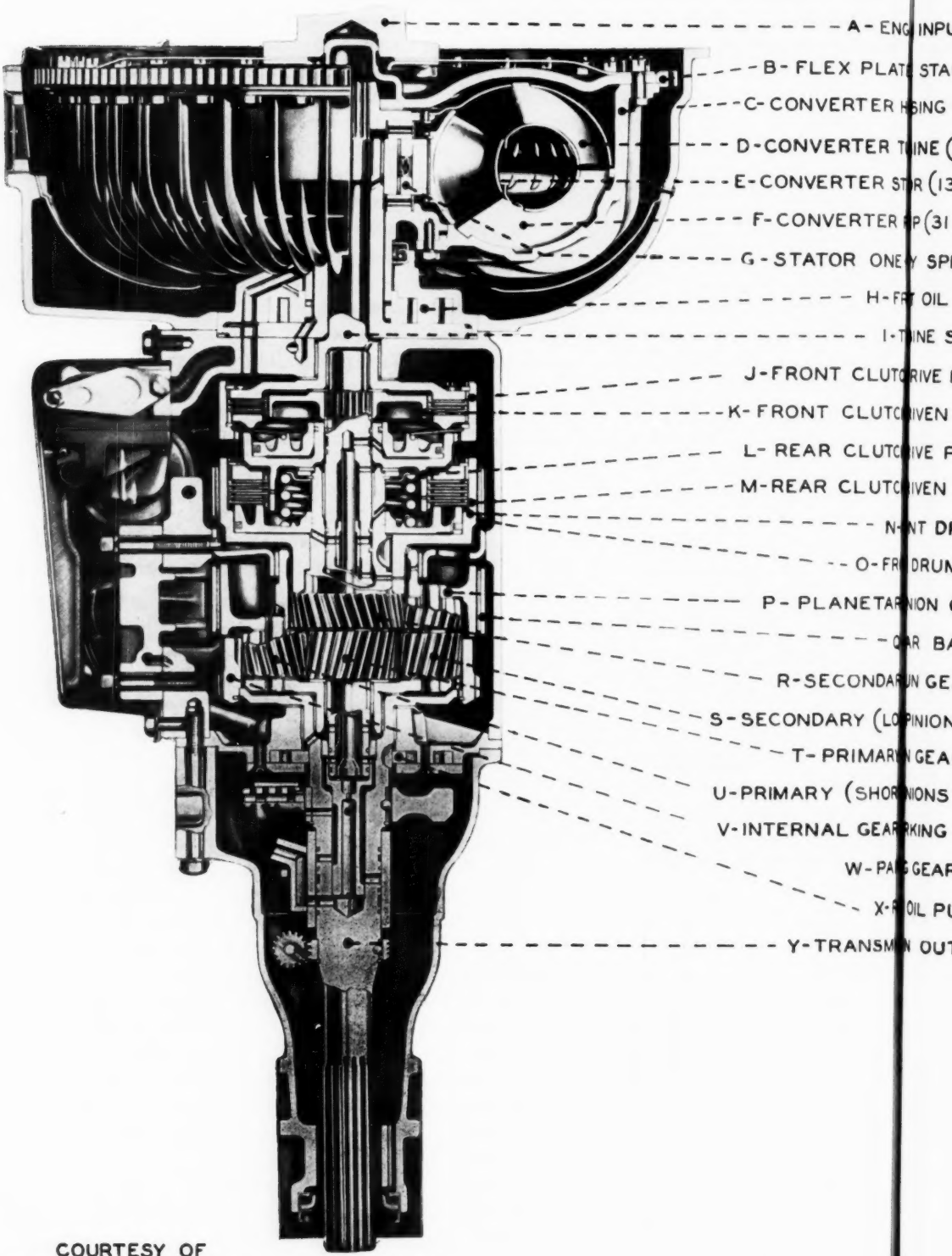



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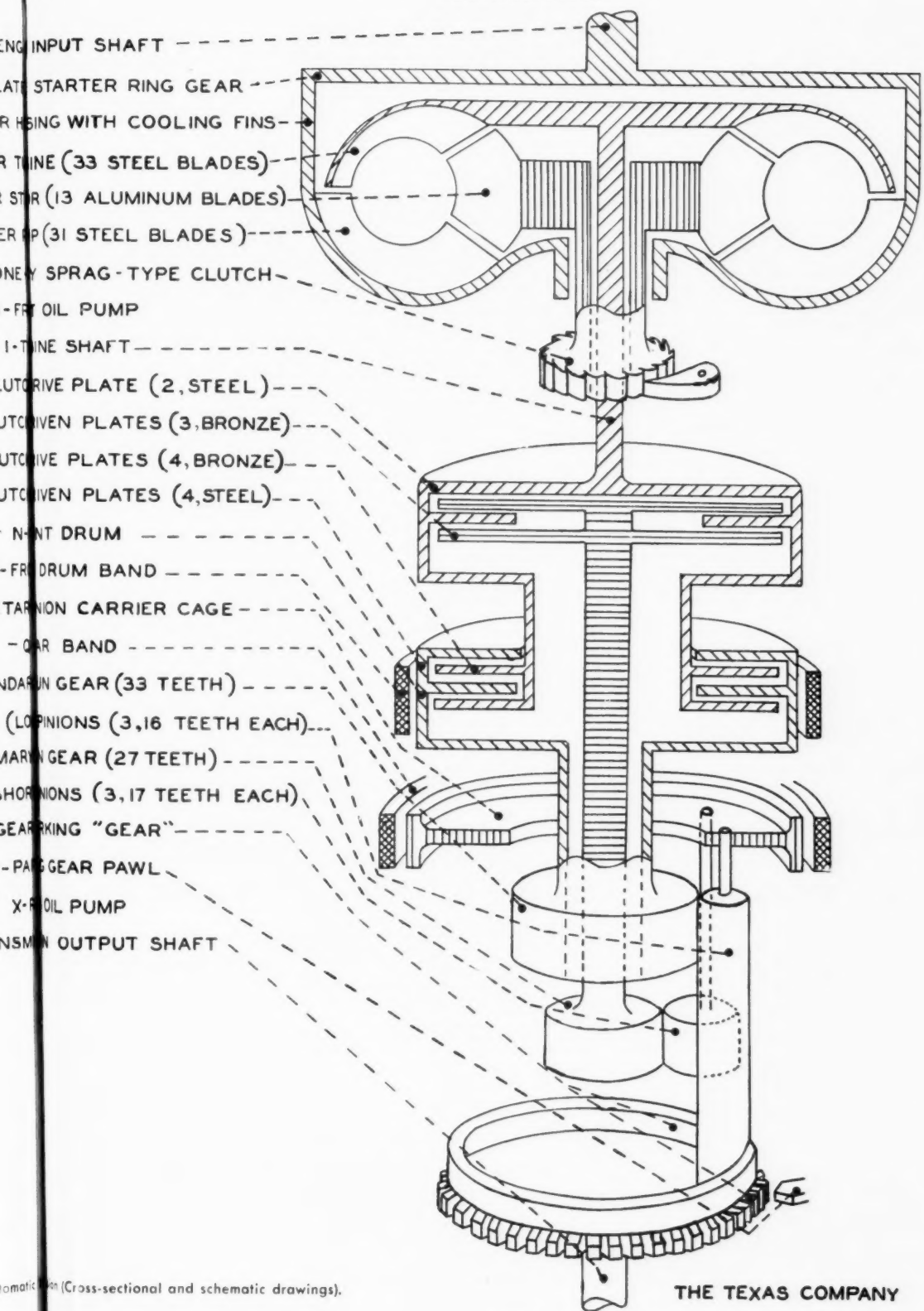
Figure 4 — The Ford-Mercury Automatic on (Cross




omatic ...n (Cross-sectional and schematic drawings).

THE TEXAS COMPANY

# HYDRAULIC CONTROL SYSTEM

## (Refer to Figure 5)

| Item | *Principally Operative in Selector Lever Position* P (Engine Stopped) | R | N (Engine Idling) | Dr (Int. or 2nd Gear) | Dr (High or 3rd Gear) | Lo | Purpose |
|---|---|---|---|---|---|---|---|
| Sump[a] | V | V | V | V | V | V | Contains about 3¾ of the total of 9¾ quarts of special oil in the transmission. |
| Front Pump | | V | V | V | V | V | Supplies all of transmission's oil requirements when car is moving backwards, is stationary, or moving forward at speeds up to approx. 20 mph; always supplies converter and lubrication requirements. |
| Rear Pump | | | V | V | V | V | Supplies transmission's oil requirements only when car is moving faster than approx. 20 mph in a forward direction. |
| Front Pump, Check Valve | | | V | V | V | V | Prevents rear pump from discharging through front pump when engine is not running. |
| Rear Pump, Check Valve | | V | V | V | V | V | Prevents front pump from discharging through rear pump during low speed or reverse operation. |
| Control Pressure Regulator Valve | | V | V | V | V | V | Regulates oil pressure requirements as indicated by throttle, modulator, compensator, and governor valves. |
| Manual Control Valve | V | V | V | V | V | V | Mechanically linked to selector lever, translates driver's selection into hydraulic instructions to the transmission. |
| Shift Valve | | | | V | V | | Under governor pressure, throttle pressure and spring pressure, causes automatic upshift (from intermediate to high) or downshift in Drive range between car speeds of 17 to 65 mph. Inoperative in Lo range, hence no shift. |
| Front Clutch Apply Pressure | | | | V | V | V | To engage front clutch. |
| Rear Clutch Apply Pressure | | V | | | V | | To engage rear clutch. |
| Front Servo and Band Apply Pressure | | | | V | V[d] | V[b] | To engage front band. |
| Front Servo and Band Release Pressure | | V | | | V[d] | | To insure rapid release of front band during 2-3 upshift. |
| Rear Servo and Band Apply Pressure | | V | | | | V[e] | To engage rear band |
| Governor | | | | V | V | V | Generates "governor pressure" by varying control pressure directly with car speed. |
| Throttle Valve | | | | V | V | V | Generates "throttle pressure" by varying control pressure directly with throttle opening. |
| Front Servo Regulator Valve | | | | V | V | V[b] | Receives control pressure and reduces it to engage front band and rear clutch smoothly. |

a Not illustrated in Figure 5.

b Only if car is moving faster than 25 mph and selector lever is moved from "Dr" to "Lo".

c Only if car is moving slower than 25 mph and selector lever is moved from "Dr" to "Lo".

d Servo spring insures release of front servo and band even when both apply and release pressures are present.

| Item | *Principally Operative in Selector Lever Position* P (Engine Stopped) | R | N (Engine Idling) | Dr (Int. or 2nd Gear) | Dr (High or 3rd Gear) | Lo | Purpose |
|---|---|---|---|---|---|---|---|
| 3-2 Control Valve | | | | V | V | | During closed-throttle downshift (high to intermediate) cushions application of front band by requiring release pressure to exhaust through an orifice. At part or full throttle the 3-2 valve bypasses the orifice to secure quick front band application. |
| Downshift Valve | | | | V | V | | Permits immediate "kickdown" or forced downshift from high to intermediate at car speeds below 55 mph by substituting full control pressure for throttle pressure on shift valve. |
| Accelerator or Foot Throttle Pedal[a] | | V | V | V | V | V | Driver's control. Mechanically linked to carburetor and to transmission's throttle valve. |
| Selector Lever[a] | V | V | V | V | V | V | Driver's control linked mechanically to manual valve; used to select desired direction of car movement. |
| Transition Valve | | | | | | V | Actuated by rear band apply pressure, blocks control pressure to front band apply pressure so as to prevent front band engagement. |
| Rear Servo Regulator Valve | | V | | | | V | Cushions application of rear band by reducing control pressure. |
| Low Inhibitor Valve | | V | | | | V | Prevents direct downshift from high (3rd) gear to low (1st) gear if selector is moved from Dr to Lo and car is moving faster than 25 mph; by blocking rear band apply pressure simultaneously prevents transition valve from operating, thus permitting front band to engage to give intermediate (2nd) gear instead. |
| Throttle Modulator Valve | | | | V | V | | In Drive range only, modulates throttle pressure before applying it to compensator valve. |
| Compensator Valve | | | V | V | V | V | Varies control pressure (and consequent intensity of application of clutches and bands) according to throttle opening, road speed, and manual control valve position. |
| Converter Pressure Regulator Valve | | V | V | V | V | V | Regulates oil pressure discharge from converter and supplies pressure lubrication to transmission parts, returns excess oil to sump. |
| Torque Converter | | V | V | V | V | V | Multiplies engine torque hydraulically, automatically and independently of gearing; during cruising operation, automatically changes to fluid coupling for hydraulic "direct drive". |
| Lubricating Oil | | V | V | V | V | V | Insures pressure lubrication of transmission parts not otherwise supplied. |

libels the actual infinite-step sprag-type one-way clutch by representing it as a crude pawl and ratchet).

The designers state that such a converter-coupling produces relatively higher efficiencies in the converter range, relatively low slip (only 2.5% @ 60 mph), and corresponding lower power loss in the cruising range (where the converter operates as a fluid coupling) and a rising engine speed curve. As illustrated by the input (engine) speed curve of Figure 2, a rising engine speed characteristic permits relatively low (1500 RPM) engine speed under stall conditions while permitting the converter to exercise torque-multiplication up to car speeds as high as 48 mph. In other words, such a converter-coupling can have an unusually wide operating range, and the securance of such a range in the Ford-O-Matic is best indicated by its possession of a 2.1 stall ratio with the remarkably high coupling point of 0.9.

## Compound Planetary Gear

A second examination of the schematic portion of Figure 4 will show that the Ford-O-Matic's compound planetary is composed of the primary and secondary sun gears, a set of three primary (short) pinions, a set of three secondary (long) pinions, the planetary pinion carrier cage which carries both sets of pinions, and the internal gear. The interaction of these gears is controlled hydraulically through two multiple-disc clutches and two bands with their servo mechanisms. Figure 3 will assist those readers who may be interested in tracing out the individual actions of the planetary components, and in addition presents schematic torque flow diagrams and the resultant torque multiplication ratios.

Of particular interest is the unusual construction of the front clutch (again see photographic portion of Figure 4) which cleverly employs a spring-plate as a lever that multiplies clutch piston force approximately three times while transmitting it to the clutch plates. As will be seen later, the front band servo is also unusual in that its action is affected by the interaction of its disengagement spring and hydraulic pressures on either or both sides of its piston.

## Transmission Cooling System

The simple and direct air cooling system draws cool air through a port in the lower left side of the converter housing and discharges it at the lower right side. Such a system is not only wholly independent from the engine's cooling system, but is also self-regulating, i.e. it tends to provide the most cooling effect when the converter needs it. The effectiveness of the system is best illustrated by the results of actual tests which have shown that even after the car has towed a 4700 pound trailer up a 6% grade under full throttle in the intermediate gear of Drive range for fifteen minutes, the transmission oil temperature rose to only 200°F. above ambient atmospheric.

## Hydraulic Control and Lubrication System

Reconsideration of Figure 3 and all of its aspects of transmission operation will outline the basic requirements of the clever but necessarily complex Ford-O-Matic control system. Figure 5 not only presents a consolidated schematic diagram of all elements in the hydraulic control system but specifically illustrates the interaction of these elements when the Ford-O-Matic is operating in its most usual condition — the high or 3rd gear of the normal Dr range. For an understanding of some of the highly complex interplay that must occur in the control system under other operating conditions and selector lever positions, the reader is referred to the table titled "Hydraulic Control System" which details the time of operation and the purpose of each element. Even a casual comparison between this table and Figure 5 will illustrate the high degree of ingenuity that has been displayed: while a close examination of these data will give a good understanding of the Ford-O-Matic, those readers who must have a complete working familiarity are referred to the numerous individual diagrams and more detailed descriptions that are contained in the manufacturer's shop or service manuals.

The purposes of the control system are obvious: (1) to receive and translate into hydraulic terms the driver's will (as indicated by selector lever position, throttle opening, engine and car speed), (2) to cause and regulate the proper application or release at the proper time and sequence of the transmission clutches and bands and (3) to give the driver complete, automatic and care-free control over the transmission while at the same time preventing him from attempting or accomplishing any actions that could be damaging either to himself or to the Ford-O-Matic or to the car.

A brief study of Figure 5 will indicate that the principal elements of the system are the now-customary two oil pumps, a speed-sensitive governor-valve, fifteen different automatic piston valves, the afore-

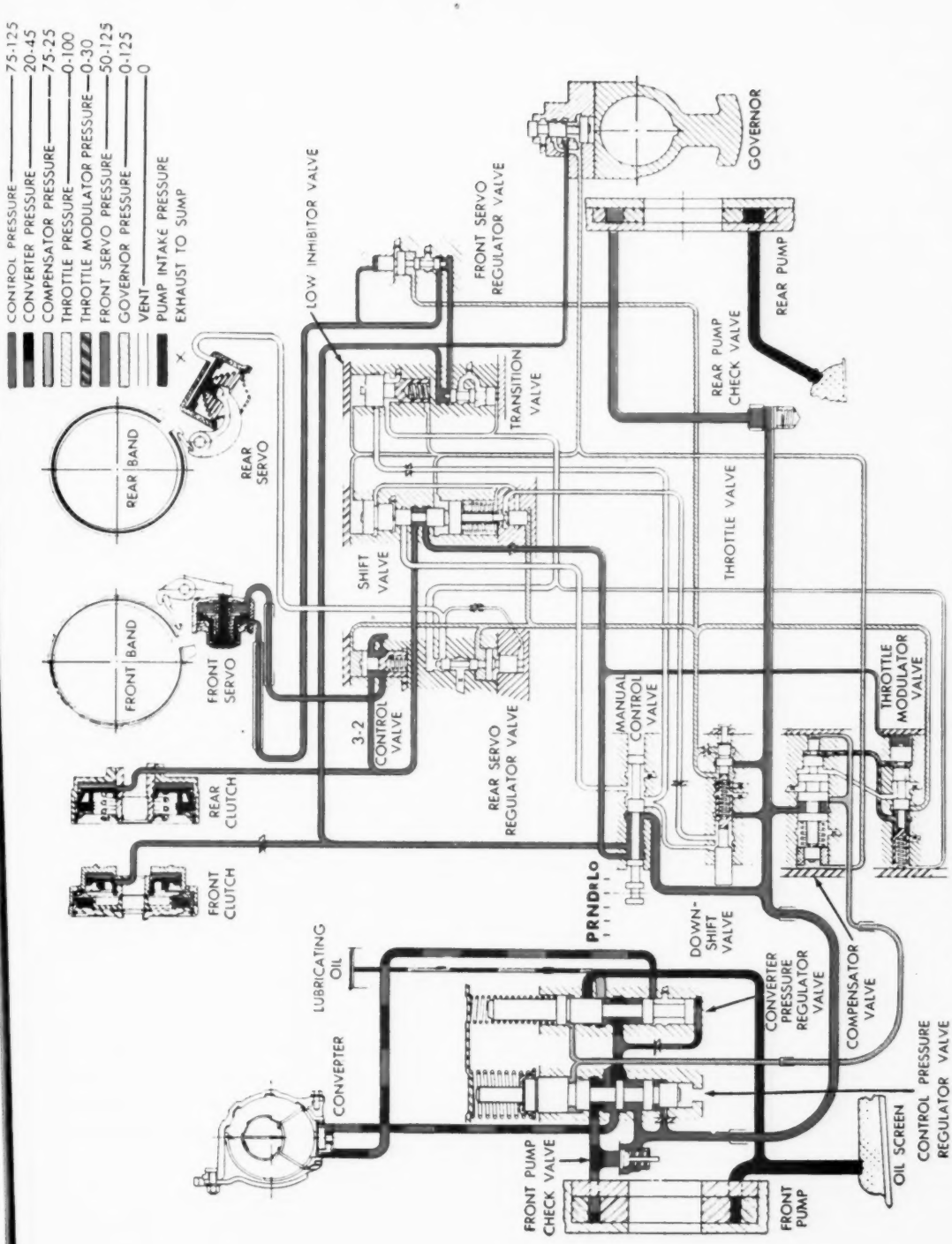



Figure 5 — Schematic diagram, Hydraulic Control System (Drive range, 3rd or high gear).

mentioned two multi-disk clutches, two bands with their servo mechanisms, the converter-coupling, and of course the hydraulic fluid itself. Nine of these valves are of the spring-loaded type, which means that they will move and remain as far away from their springs as possible until and unless superior opposing hydraulic pressures are applied to them. Almost all of the automatic valves are concentrated within the Control Valve Body which is thus the combined heart, brain and nerve center of the Ford-O-Matic, and which principally consists of four aluminum precision die castings each with intricately cored valve chambers, ports and connecting passages. Through careful design of the control valve body, practically all of the external hydraulic tubing that would otherwise be necessary has been eliminated.

## TRANSMISSION FLUID

From the preceding description of the Ford-O-Matic, the reader should readily deduce that the fluid to be used in it is also a very important part of the assembly. The fluid not only has its own several functions to perform, but it must also assist and protect all of the associated mechanical parts. Since each separate function requires certain specific properties, the task of successfully combining all of them into a single "universal" fluid has been difficult.

Basically the fluid is a high quality light mineral oil, but since no simple straight mineral oil is capable in itself of meeting all of the diverse requirements, the base oil must be reinforced with a considerable number of specialized chemicals. Keeping in mind that the primary requirement of the fluid is that it do its many jobs perfectly in the Ford-O-Matic during at least 15000 miles of widely-variable operating conditions, the reader will realize that while the following properties are highly important, they are only indicative of the general nature of the fluid.

### High Oxidation Resistance

As the fluid is circulated through the converter-coupling and planetary gearing it is heated and intimately mixed with atmospheric oxygen, which would quickly oxidize an ordinary oil. However, even a relatively small amount of oxidation might cause the formation of sludge or varnish and either of these undesirables could prevent proper operation of the Ford-O-Matic. It is therefore paramount that the fluid not only possess a high degree of oxidation resistance, but that it be regularly replaced every 15000 miles with new fluid of equal quality.

### Viscosity, Viscosity Index and Low Temperature Properties

The combined requirements of the converter-coupling, the hydraulic system, pumps, valves, bearings, gears, clutches and bands all dictate that the fluid have a summer "high-temperature" viscosity of at least 49 S.U. seconds at 210°F. However the same fluid will be used during both summer and winter, hence its winter "low-temperature" viscosity must be as *low* as possible. When combined, these conflicting requirements dictate a very high viscosity index.

### Oiliness

The smooth engagements of the two multi-disk clutches and bands are assisted by the presence of a fair degree of "oiliness" in the fluid and this peculiar property is not found in ordinary oils. Furthermore, this "oiliness" characteristic is particularly valuable during the initial operation of a new transmission since it assists in the "running in" of the new parts.

### Foam Resistance

As in most hydraulic systems, the presence of any appreciable air-oil foam can not be tolerated in a Ford-O-Matic since foam interferes with proper operation of the valving, decreases or destroys converter action, promotes violent expulsion with loss of fluid, and accelerates oxidation. An unusually high degree of foam resistance is therefore essential.

### Chemical Activity

The fluid must not harm any of the metals, gaskets, rubber seal rings or other materials used in the Ford-O-Matic. On the other hand, the fluid should exert such beneficial chemical activities as rust prevention and mild detergency or cleansing ability.

### Availability

Fortunately for all concerned a number of fluids which meet these severe requirements are now readily available for retail purchase through both Ford[11] and Lincoln-Mercury[12] dealers and through oil company service stations.[13]

[11]Ford "Automatic Transmission Fluid", Service Part No. 1/24-1A-19582-A

[12]Lincoln-Mercury "Oil for Merc-O-Matic and Hydromatic Transmission", Service Part No. 8L-19582-C

[13]While the trade names of qualified fluids will vary, all of them must embody the word "Automatic Transmission Fluid—Type "A" and all containers must bear the letters AQ-ATF followed by a number, viz AQ-ATF-102.



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